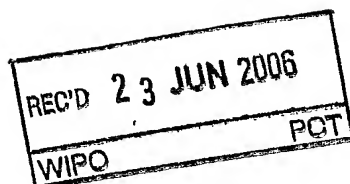# PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 21017798	FOR FURTHER ACTION See Form PCT/IPEA/416	
International application No. PCT/SE2005/000393	International filing date *(day/month/year)* 18-03-2005	Priority date *(day/month/year)* 22-03-2004

International Patent Classification (IPC) or national classification and IPC

See Supplemental Box

Applicant

Contextvision AB et al

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of __6__ sheets, including this cover sheet.

3. This report is also accompanied by ANNEXES, comprising:

   a. ☒ *(sent to the applicant and to the International Bureau)* a total of __4__ sheets, as follows:

   ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).

   ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.

   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s))
   _____ , containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

   ☒ Box No. I   Basis of the report

   ☐ Box No. II   Priority

   ☐ Box No. III   Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

   ☐ Box No. IV   Lack of unity of invention

   ☒ Box No. V   Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

   ☐ Box No. VI   Certain documents cited

   ☐ Box No. VII   Certain defects in the international application

   ☐ Box No. VIII   Certain observations on the international application

Date of submission of the demand 24-10-2005	Date of completion of this report 31-05-2006
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. +46 8 667 72 88	Authorized officer Jesper Bergstrand /LR Telephone No. +46 8 782 25 00

Form PCT/IPEA/409 (cover sheet) (April 2005)

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**

Continuation of: Cover sheet

International patent classification (IPC)
G06T 5/50 (2006.01)

Box No. I	Basis of the report

1. With regard to the **language**, this report is based on:

    ☒ the international application in the language in which it was filed

    ☐ a translation of the international application into _____ ,
    which is the language of a translation furnished for the purposes of:

    ☐ international search (Rules 12.3(a) and 23.1(b))

    ☐ publication of the international application (Rule 12.4(a))

    ☐ international preliminary examination (Rules 55.2(a) and/or 55.3(a))

2. With regard to the **elements** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report):*

    ☐ the international application as originally filed/furnished

    ☒ the description:

        pages   1-16 _____ as originally filed/furnished

        pages* _____ received by this Authority on _____

        pages* _____ received by this Authority on _____

    ☒ the claims:

        pages _____ as originally filed/furnished

        pages* _____ as amended (together with any statement) under Article 19

        pages*   17-20 _____ received by this Authority on   03-05-2006 _____

        pages* _____ received by this Authority on _____

    ☒ the drawings:

        pages   1-6 _____ as originally filed/furnished

        pages* _____ received by this Authority on _____

        pages* _____ received by this Authority on _____

    ☐ a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

    ☐ the description, pages _____

    ☐ the claims, Nos. _____

    ☐ the drawings, sheets/figs _____

    ☐ the sequence listing *(specify)*: _____

    ☐ any table(s) related to the sequence listing *(specify)*: _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

    ☐ the description, pages _____

    ☐ the claims, Nos. _____

    ☐ the drawings, sheets/figs _____

    ☐ the sequence listing *(specify)*: _____

    ☐ any table(s) related to the sequence listing *(specify)*: _____

* *If item 4 applies, some or all of those sheets may be marked "superseded."*

| Box No. V | Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement |

1.   Statement

Novelty (N)	Claims	1-18	YES
	Claims	19	NO
Inventive step (IS)	Claims	1-18	YES
	Claims	19	NO
Industrial applicability (IA)	Claims	1-19	YES
	Claims		NO

2.   Citations and explanations (Rule 70.7)

The invention concerns a method, an apparatus and a computer program product for improving a digital image, and more specifically a computerized tomography (CT) image consisting of reconstructed data. The invention solves the problem of storing the result of enhancement processing into one image and it also enables switching between intensity windows in case different tissues are to be examined.

The object of the invention is to provide an improved method for improving a CT image.

Cited Documents:

D1: US5715334 A
D2: US5594767 A
D3: US20040024302 A
D4: US5655532 A

Document D1 is considered to represent the closest prior art. D1 describes a method for digital image detail enhancement for X-ray or mammogram.
From document D1, a method for enhancing a first digital image composed of a plurality of elements, each having an intensity value is known (refer to column 1, line 57-column 2, line 38 and abstract), wherein a first digital image is received (refer to column 30, lines 37-38); a plurality of copies of said first image are provided by enhancement processing based on said first digital image (refer to figure 26 and column 33, line 42-column 34, line 63); said enhancement processing being performed with respect to predetermined intensity value ranges; and wherein said plurality of copies of said first digital image are combined with said first digital image, whereby an enhanced digital image is

. . ./. . .

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of: Box V

provided, said combining being based on a classification with respect to intensity values of regions within said first digital image and said plurality of copies of said first digital image (refer to abstract, claim 1, figures 30A-30F and column 36, line 57-column 37, line 23).

One could argue that the plurality of (enhanced) copies of the first digital image are not combined with the first digital image into one image.

However, from claim 1 of D1 it is clear that the differential image data array is added to the first image data array.

Further, from figure 26 in D1 it is clear that a plurality of processed copies of the first digital image are generated and since it is the examiners opinion that the differential images with different scaling (refer to figure 26) can be seen as one image (refer also to figures 30A-30F and column 36, line 57-column 37, line 23), the present invention according to claim 19 does not differ from the teachings of document D1.

Thus, the present invention according to claim 19 lacks novelty over D1.

The Applicant's Agent argues in the letter received 16-01-2006 that the method of the present invention uses average intensities, whereas D1 does not. However, the examiner can not find any references to "average intensities" in claim 19 of the present invention.

In the above-mentioned letter the Applicant's Agent also argues that the copied images of D1 do not contain any DC information, whereas the corresponding images of the present invention do. However, the examiner can not find any references to "DC information" in claim 19 of the present invention.

Moreover, in the above-mentioned letter the Applicant's Agent also argues that the method of the present invention deals with the combination of differently enhanced images, which is based on the local DC intensity level (the Hounsfield scale), whereas D1 does not. However, the examiner can not find any references neither to "DC intensity level" nor to "Hounsfield scale" in claim 19 of the present invention.

In the above-mentioned letter the Applicant's Agent further argues that the inventive method of the present invention is based upon Hounsfield values, whereas document D1 is not. However, the examiner can not find any references to "Hounsfield values" in claim 19 of the present invention.

.../...

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of: Box V

However, the invention defined in claims 1-18 is not disclosed by any of the above cited documents (D1-D4).

The cited prior art does not give any indication that would lead a person skilled in the art to the claimed method for enhancing a first CT image composed of a plurality of elements, each having an intensity value in Hounsfield units indicative of a tissue type, the method comprising: receiving said first CT image; providing, by enhancement processing based on said first CT image; a plurality of copies of said first CT image, said enhancement processing being performed with respect to predetermined intensity value ranges; and combining said plurality of copies of said first CT image with said first CT image, whereby an enhanced CT image is provided, said combining being based on a classification with respect to intensity values of regions within said first CT image and said plurality of copies of said first CT image.

Therefore, the claimed invention is not obvious to a person skilled in the art.

Accordingly, the invention defined in claims 1-18 is novel and is considered to involve an inventive step.

Consequently, the claimed invention according to claim 19 lacks novelty over D1, whereas the claimed invention according to claims 1-18 is novel, and considered to involve an inventive step.

Further, the claimed invention according to claims 1-19 is industrially applicable.

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CLAIMS

1. A method for enhancing a first CT image composed of a plurality of elements, each having an intensity value in Hounsfield units indicative of a tissue type,
5 the method comprising:

receiving (101) said first CT image,

providing, by enhancement processing (103) based on said first CT image, a plurality of copies of said first CT image, said enhancement processing (103) being
10 performed with respect to predetermined intensity value ranges, and

combining (104) said plurality of copies of said first CT image with said first CT image, whereby an enhanced CT image is provided, said combining being based
15 on a classification with respect to intensity values of regions within said first CT image and said plurality of copies of said first CT image.

2. The method of claim 1, further comprising receiving an indication of said predetermined value
20 ranges and associating said predetermined intensity value ranges with said plurality of copies of said first CT image.

3. The method of claim 1, wherein said enhancement processing (103) is adaptive to a local structure defined
25 by at least some of said plurality of elements.

4. The method of claim 3, wherein said local structure is defined by a group of elements whose intensity values are within said predetermined intensity value ranges.

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5. The method of claim 1, wherein said enhancement processing (103) comprises applying a non-linear filter to said plurality of copies of said first CT image.

6. The method of claim 1, wherein said enhancement
5   processing (103) is selected from a group consisting of a noise reduction using a low pass filter, a contrast enhancement using unsharp masking, a rank filtering, an adaptive filtering, a mean-shift filtering, a variational method, a multiband technique and a wavelet technique.

10   7. The method as claimed in any one of the preceding claims, wherein combining (104) said plurality of copies of said first CT image with said first CT image comprises:
        determining (1042) a first region mask for said
15   first CT image, said first region mask defining an area within the first CT image, whose elements have intensity values within a first intensity value range,
        determining (1042) a respective additional region mask for said plurality of copies of said first CT image,
20   said respective additional region mask defining an area within a respective copy of said first CT image, whose elements have intensity values within said predetermined intensity value ranges, and
        combining (1046) said first CT image and said
25   plurality of copies of said first CT image, weighted by their respective region masks, whereby said enhanced CT image is provided.

8. The method of claim 7, further comprising prioritizing (1041) said first CT image and said
30   plurality of copies of said first CT image, whereby an element of a CT image having a higher priority is

AMENDED SHEET

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included in the enhanced CT image and a correspondingly located element of a CT image having a lower priority is excluded from the enhanced CT image.

9. The method of any one of claims 7 or 8, further comprising smoothing (1044) said region masks.

10. The method of any one of claims 7-9, further comprising normalizing (1045) said region masks.

11. The method of any one of claims 7-10, further comprising subjecting at least one of said region masks to a morphological closing and/or opening algorithm.

12. The method of any one of the preceding claims, wherein said first CT image is selected from a group consisting of a two-dimensional array, a three-dimensional array and a four-dimensional array.

13. The method as claimed in any one of the preceding claims, wherein said first CT image is subjected to a second enhancement processing prior to said combining (104).

14. The method as claimed in claim 13, wherein said second enhancement processing is performed with respect to a second predetermined intensity value range.

15. A computer program product comprising software code portions for performing the steps of any one of claims 1-14, when said product is run on a computer.

16. A storage medium having stored thereon a computer program product according to claim 15.

17. A propagated signal comprising components for performing the steps of any one of claims 1-14.

18. A device for enhancing a first CT image composed of a plurality of elements, each having an intensity value in Hounsfield units indicative of a tissue type, the device comprising:

5   receiving means (2) for receiving said first CT image,

processing means (3) arranged for providing, by enhancement processing (103) based on said first CT image, a plurality of copies of said first CT image, said
10 processing means (3) being adapted for enhancement processing with respect to predetermined intensity value ranges, and

means for combining (104) said plurality of copies of said first CT image with said first CT image, whereby
15 an enhanced CT image is provided, said combining being based on a classification with respect to intensity values of regions within said first CT image and said plurality of copies of said first CT image.

19. A method for enhancing a first digital image composed
20 of a plurality of elements, each having an intensity value, the method comprising:

receiving (101) a first digital image,

providing, by enhancement processing (103) based on said first digital image, a plurality of copies of said
25 first digital image, said enhancement processing (103) being performed with respect to predetermined intensity value ranges, and

combining (104) said plurality of copies of said first digital image with said first digital image,
30 whereby an enhanced digital image is provided, said combining being based on a classification with respect to intensity values of regions within said first image and said plurality of copies of said first image.